SEMI-ANNUAL STATUS REPORT

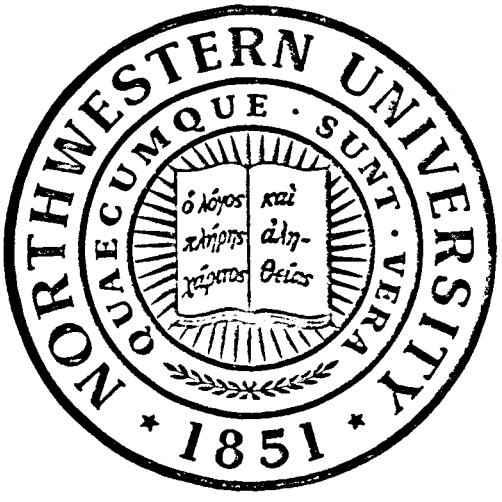
1 June 1966 - 30 November 1966

A PATROL OF THE LUNAR SURFACE WITH A 24-INCH REFLECTOR AND IMAGE ORTHICON SYSTEM

597
(NASA Grant NsG-~~497~~/14-007-016)

Submitted by

J. Allen Hynek, Director
Dearborn Observatory
Lindheimer Astronomical Research Institute



Northwestern University
Evanston, Illinois 60201

NARRATIVE ACCOUNT OF ACTIVITIES DURING PERIOD

The conduct of a patrol of the lunar surface continues to be the primary activity in the Corralitos Observatory research program. At the end of this report period, 1 June - 30 November 1966, the lunar surveillance program reached its first anniversary of routine operation. No observing time has been lost due to equipment breakdown or to personnel problems during this period. The moon has now been continually observed with the 24-inch reflector and image orthicon system, whenever it is above the horizon in Las Cruces, New Mexico, during clear nighttime hours, for over 1200 hours.

With regard to meteorological conditions the Corralitos records have shown that this report period coincided with the poor weather season at Las Cruces. June was the wettest month on record and September also experienced above average precipitation. Winds were not a significant factor although cloud cover hampered observations in the early part of the period but became less of a problem after September. Despite the relatively poor weather conditions the lunar surveillance program logged over 400 observing hours throughout this report period. In view of the foregoing the Corralitos Observatory continued to fulfill its mission of monitoring the lunar surface most satisfactorily, and it can be reasonably stated that during the observing hours logged in this report period no transient phenomena on the lunar surface within the detection capability of the Corralitos electro-optical system have occurred.

As mentioned in the previous report the surveillance program has been expanded beyond the original scope of operation. In addition to the primary red-blue blink patrol of selected areas a concurrent

program of infrared observations of the lunar surface has been made a regular part of the surveillance activity. A second television chain incorporating an S-1 photocathode I.O. and a separate optical system of 2-1/2 - inch aperture with an interference filter operating in the wavelength region of 8,000-10,800 Å is mounted piggyback on the 24-inch telescope tube. Laboratory tests have shown that this approach should provide the surveillance program with the capability of detecting highly localized thermal changes on the moon which might not have a corresponding visual change. The lunar patrol has been further expanded to include visual observations of the earthlit portion for 4-5 nights after new moon with a 12-inch Cassegrain reflector. By observing simultaneously with the 24-inch/I.O. system we have noted that small bright craters on the threshold of resolution frequently appear to brighten for an instant during moments of exceptionally stable seeing. This probably explains the frequent reports by Astro-Net of visual observations of bright flashes on the earthlit portion of the moon.

The observational program has remained basically the same from the start of the project. Selected areas of the moon where surface activity has been most frequently reported are systematically patrolled each night. Included are Aristarchus, Alphonsus and Copernicus among others. Red-blue blink observations are concentrated on particular features as reports of changes thereon are made by other observatories. The Corralitos Observatory also continues to monitor the Astro-Net transmissions looking toward confirming the lunar transient phenomena reported by Moon Blink and other amateur groups. Reports of surface activity sightings and confirmations by Astro-Net were heard throughout this report period although the volume

of such reports was somewhat less than in the past. A partial explanation was simply that radio interference made monitoring the Astro-Net very difficult at times during this period, particularly in June and July when only a few reports of bright flashes and star-like objects of very short duration were heard.

An attempt is made to confirm each sighting as they are reported over Astro-Net, but to date none of these observations have been confirmed at Corralitos. Only a relatively small percentage of the negative results can be attributed to Corralitos being closed in by total cloud cover. As an example, on universal day 27 August Astro-Net reported flashes around Alphonsus and a definite change from one hour to the next in the craterlet Ross B. The Corralitos observers did not detect any bright flashes in the Alphonsus area during this night as reported by the Astro-Net members, but the change in Ross B through the night was easily detected with the 24-inch telescope/I.O. system to be the changing illumination angle on the crater. In September several observations of bright flashes and brightening on the lunar surface in the Aristarchus region were reported by Astro-Net members while observing the earthlit portion of the moon, but again could not be confirmed by the lunar surveillance program at Corralitos. In addition to the systematic patrol and the attempts to verify Astro-Net sightings the Corralitos observing program includes other events of particular interest to NASA. On the 2nd of June the landing site of Surveyor I was observed. No albedo or other surface changes resulting from the firing of the lunar vehicle retro-rockets could be detected.

EQUIPMENT AND FACILITIES

During this period a special report was prepared for Dr. W. E. Brunk comparing the Corralitos lunar surface patrol with the Moon Blink and Argus Astro-Net programs. Unquestionably the comparison pointed out the greater capability of the Corralitos operation. From the standpoint of telescope aperture it is very doubtful that Moon Blink and Astro-Net instruments can match Corralitos' 24-inch instrument or even its auxiliary visual 12-inch telescope. This comparison is significant in that perhaps the most respected reports of lunar surface changes are those of Greenacre and Barr in late 1963. These observations were made with a 24-inch telescope and confirmed with the Perkins 69-inch reflector, but the phenomena could not be detected with the 6-inch finder telescope or other smaller instruments. Another point brought out in the comparison is that the majority of Astro-Net and Moon Blink telescopes are located at or near sea level with the greatest number of them located in or near cities. On the other hand, the Corralitos location has proven exceptionally good and, indeed, can be placed on a par with the major U.S. observatories regarding both seeing conditions and number of observable hours throughout the year.

From the standpoint of observing methods and instrumentation the Corralitos operation is also superior to the Moon Blink and Astro-Net operations. In the latter programs viewing is done at the telescope eyepiece while viewing is done at the TV monitor at Corralitos. The advantages of observing in a closed room with controlled conditions as at Corralitos are obvious. Further, because cameras are permanently mounted at the Corralitos monitors, photographic records can be made simultaneously

with the visual observations. To the best of our knowledge, this capability does not exist at any of the Moon Blink or Astro-Net sites; in fact, most are probably not even equipped for photographic recording and those that are would most likely have to remove the eyepiece from the telescope, insert the camera, and re-focus before photographic records could be made.

Available to the lunar surveillance program at Corralitos are a number of image orthicon tubes with a variety of photocathodes. An S-10 photocathode tube is used in the primary I.O. system for approximately four months of the year when weather conditions during the cloudy season hamper more than two-color filter blinking. It should be pointed out that since practically all observations of lunar color phenomena in the red region of the spectrum throughout astronomical history have been made visually, the S-10 photocathode is used because its response extends 600 Å farther into the near infrared than the human eye. Although the relative sensitivity of the S-10 photocathode at wavelengths longer than 6900 Å is quite low, the gain in the image orthicon chain permits useful information to be realized at these longer wavelengths. Except during the cloudy summer months an S-20 photocathode tube, which has a spectral response of 3000 to 8500 Å, is normally used in the Corralitos surveillance project. Moon Blink also uses an S-20 photocathode tube which extends approximately 1000 Å farther into the red than the S-10 photocathode, but since the gain of the image tube used in the Moon Blink system is much lower than that in the Corralitos image orthicon system, it is improbable that they are obtaining useful information at wavelengths longer than 7500 Å. As mentioned previously, S-1 photocathode tubes are employed in

the near IR image orthicon chain used at Corralitos simultaneously with the main IO system. The spectral response of these tubes is 3000-10,800 Å, but all wavelengths shorter than 8000 Å are filtered out in the IR system.

A comparison of filter systems shows that Moon Blink uses two rapidly rotating filters in the optical path, wratten gelatin filters No. 29 for red transmission and No. 44A for blue. As these filters are not mounted in optical glass the unlevel surface as it passes through the optical path permits constant excursion of the viewed image which in turn causes frequent watering in the eyes of the Moon Blink observers. The Corralitos filter system comprises a rotating filter wheel with four filter positions and with two rotation speeds of one revolution and two revolutions per second. Interference filters of dielectric coatings laminated between optical glass permit the individual leveling of filters in the rotating wheel, thus eliminating any image excursion as exists in the Moon Blink system. During most of the year 3-color filter blinking is utilized at Corralitos covering the spectral ranges of 3500-4600 Å, 4600-6000 Å, and 6000-8000 Å. It would appear that the filtering techniques presently used at Corralitos are far superior to the Moon Blink techniques and permit better evaluation of the pictures presented at the TV monitor with a minimum of eyestrain.

Finally, it is virtually certain that none of the Astro-Net or Moon Blink locations can match the supporting facilities at Corralitos such as a shop for equipment maintenance or repair, an astronomical library, or other conveniences available at a permanent observatory site.

PERSONNEL

The Corralitos observing staff has continued to build up vast

experience in the lunar surveillance activity due to its long-term stability. During this report period there has been one personnel turnover: R. Cooper, an observing assistant, left the program to concentrate on full-time college studies and was replaced by G. Emerson on 1 September 1966. However, J. R. Dunlap continues as resident astronomer and in charge of Corralitos operations, and W. Ohlhausen and J. Gallivan remain as observers. As mentioned in the previous report, the lunar patrol is being operated by an extremely competent observing team. It bears repeating that the majority of the original staff remains on the program and still demonstrates high morale despite the routineness of the observing program. This is attributable in part to the the opportunity of participating in other related observing programs made possible by the large complement of instrumentation at Corralitos, and mainly to the attitude of the staff itself. The observing staff is very interested in the lunar work and constantly strive to improve and refine the equipment or observing techniques. During the report period the staff was able to give full coverage to the lunar patrol and to perform all other related observatory duties despite the one personnel change and the summer vacation period. The Corralitos field staff still receives all necessary support from the technical staff at the Dearborn Observatory.

PLANS AND RECOMMENDATIONS

It can be agreed upon by all concerned that the conduct of the lunar surface patrol at Corralitos Observatory has been a highly productive operation. Productive can be and should be interpreted as meaning results of either polarity. Quite naturally, it is hoped that the patrol will be

able to detect measurable lunar changes, but it so happens that to date all of the results of the patrol have been negative. However, negative results in this particular program have valid significance. Over the past twelve months that the program has been fully operational despite the numerous reports of suspected changes made by other groups, none have been verified at Corralitos. We can, therefore, state with considerable confidence that no color or feature change within the detection capabilities of the present instrument has occurred on the lunar surface. With the 24-inch reflector, under good seeing conditions and with the resolution of the image orthicon system, we are confident that distinct changes occupying somewhat more than one square second of arc on the lunar surface would be detectable. The present staff, well versed in image orthicon techniques, can be expected to detect significant changes even though such small angular areas are involved.

In view of the foregoing the present program, to include the regular red-blue blink patrol, the simultaneous infrared observations, and the visual observations immediately after new moon with the 12-inch reflector, will be continued in full force over the next 6-month period. The Argus Astro-Net will be regularly monitored looking to the immediate investigation of those areas of the moon where changes are reported by amateur observers as well as by other groups for verification purposes.

It is recommended that NASA support for the Corralitos lunar surveillance program be continued because of the growing need to gather all possible information about the lunar surface. The Corralitos Observatory

represents the only professional astronomical group actively engaged in a lunar surface patrol as its principal project. Indeed, we view the Corralitos operation as a clearing house for monitoring reports of transient lunar phenomena and alerting other observatories with larger instruments if we have verified such reports.

The transistorized television originally developed for the Corralitos program has undergone a major overhaul whereby system stability has been optimized and the gain increased significantly. The modified system will be returned to Corralitos in early 1967 and the RCA system currently in use will revert to back-up status. During the laboratory testing of the modified system the feasibility of electronically increasing the red-blue blink rate through the incorporation of a second identical I.O. camera was determined. In the forthcoming proposal for the continuation of the lunar surface patrol there will be a recommendation that such a course of action be followed. Basically, the present TV camera will be duplicated so that two identical units, one equipped with a red filter and the other with a blue filter, can be tied into the same control circuitry. By means of a beam splitting device and switching circuitry a red picture and a blue picture of the same lunar feature can be presented alternately to the same viewing monitor. The blink rate in this method would be 1/20th of a second since the scan rate of the I.O. cameras would be 20 frames per second.

The 12-inch reflector mentioned previously in this report is presently located at the Organ Mountain Station, a separate observing site. Plans are underway to re-locate this instrument to Corralitos, a move

which will greatly facilitate the continuation of visual observations of the earthlit portion of the moon shortly after new moon.

The Corralitos electro-optical system will continue to be used for other observing programs when the moon is not available. Since a supernova search in galaxies is completely compatible with the lunar patrol, plans are being made to undertake such a program on a full-scale, automatic basis.